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Multiple Object Tracking Reveals Object-Based Grouping Interference in Children with ASD

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Abstract The multiple object tracking (MOT) paradigm has proven its value in targeting a number of aspects of visual cognition. This study used MOT to investigate the effect of object-based grouping, both in children with and without autism spectrum disorder (ASD). A modified MOT task was administered to both groups, who had to track and distinguish four targets that moved randomly amongst four distracters, irrespective of the grouping condition. No group difference was revealed between children with and without ASD: both showed adequate MOT abilities and a similar amount of grouping interference. Implications of the current result are considered for previous MOT studies, the developmental trajectory of perceptual grouping, and the idea of heightened sensitivity to task characteristics in ASD.

Keywords Autism spectrum disorder (ASD) · Multiple object tracking (MOT) · Vision research · Grouping · Interference · Attention

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Introduction

Autism spectrum disorders (ASD) are mainly characterized by deficits in social reciprocity and social communication, as well as repetitive and stereotyped patterns of behavior and interests (American Psychiatric Association 2013). Although atypical visual processing is not one of the core diagnostic criteria of ASD, the most recent version of the DSM, the DSM-5 has started to highlight atypical sensory processing, in particular in the visual domain (American Psychiatric Association 2013). This trend is remarkable and a strong indication of the importance of sensory aspects in capturing ASD pathology.

Since the early ‘80s, atypical perceptual organization in ASD has grown into a major research topic (Simmons et al. 2009). The key question pertains to the (perturbed) balance between local processing of small details and global processing of larger configurations. While some researchers report findings of enhanced local or detail-oriented processing in ASD, others report deficits in global or holistic processing or a lack of (spontaneous) global tendencies. The existing evidence is mixed and the discussion is complicated by a true chicken-or-egg causality debate between two frameworks, namely the weak central coherence (WCC) theory and the enhanced perceptual functioning (EPF) hypothesis. Although both frameworks differ in a number of ways, both have tried to characterize the atypical visual processing in ASD. The WCC framework has launched the idea that individuals with ASD suffer from WCC or, in other words, an inability to integrate elements of information into coherent wholes (Frith and Happé 1994; Happé and Booth 2008; Happé and Frith 2006). According to Frith (1989), WCC in ASD stems from a core deficit in central processing and a failure to extract global form and meaning. This deficit-idea, however, has now been reformulated to

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suggest an atypical, more detail-focused processing style to underlie these differences. The particular processing style can be overcome in situations with explicit demands for global processing (Happé and Booth 2008). The EPF hypothesis, however, suggests superior low-level perceptual performance in ASD, without making assumptions about the ability to process global information. The EPF hypothesis advocates that individuals with ASD display enhanced low (e.g., discrimination) and mid-level (e.g., pattern detection) information processing, as well as a default locally oriented processing style (Mottron and Burack 2001; Mottron et al. 2006). In addition, Mottron et al. (2013) introduced veridical mapping as underlying mechanism of pattern detection for EPF, bridging ASD peak abilities and neural correlates involved in EPF. Their neuronal perspective on the cognitive differences between ASD and typically developing suggests a more mandatory basis for EPF compared to an "optional cognitive style" proposed by Happé and Booth (2008).

The extensive research on mid-level visual processing in ASD conducted so far has provided us with a broad range of results and insights. Yet, much of the conducted local–global visual research has led to mixed results and has left us with unresolved, key questions (for a review, see Dakin and Frith, 2005; for a recent meta-analysis, see Van der Hallen et al. 2015).

One paradigm that can help shed light on this debate is that of multiple object tracking (MOT), first developed by Pylyshyn and Storm (1988). In MOT, participants are asked to track a number of targets that are moving independently and unpredictably amongst a specific number of moving distracters. The task involves attention to multiple objects rather than focal attention to a single object and is inherently active in nature, as mere passive vigilance will not suffice for good task performance (Scholl 2009). The task itself is quite easy and on first sight, there does not seem much to it. The strength, however, lies in its versatility and the extent to which one can modify the paradigm in order to investigate a wide variety of aspects of visual cognition. Previous researchers, for example, have employed the paradigm to address grouping, working memory, task switching, spatial resolution, occlusion, dual-task interference, etc. (for an overview, see Scholl 2009). In addition, the MOT paradigm has been used to investigate individual differences in visual cognition, as well as differences between typically developing (TD) groups and specific population groups, such as young children, older adults, videogame players, as well as clinical populations such as individuals with Williams syndrome (for an overview, see Scholl 2009).

Only three published studies so far have used the MOT paradigm in an ASD population. The first study was a study by Koldewyn et al. (2013b), who used the paradigm to quantitatively characterize dynamic attentional function in children with and without ASD (5–12 years old). Although their ASD group showed a lower overall tracking capacity than their TD participants, they found no evidence for a specific dynamic attention deficit. The ASD group did not perform disproportionately worse at higher speeds compared to lower speeds, but instead, showed a similar performance deficit at all speeds. Therefore, the authors concluded that temporal/dynamic stimuli might not pose special processing challenges for individuals with ASD, as was previously suggested.

The second study to administer the MOT task to individuals with ASD was conducted by O'Hearn et al. (2013), who evaluated the effect of common motion. A group of children, adolescents, and adults (respectively 9–12, 13–17 and 18–26 years old) was presented with three different MOT conditions: an ungrouped, baseline condition and two grouped conditions where 'grouping' of pairs was achieved by using common motion. In the 'grouping helps' condition, each target was paired to another target, while distractors were paired to distractors. In the 'grouping hurts' condition, each target was paired to a distractor. Note that no other grouping cues were present (e.g., connecting line) but common motion. Results revealed a main effect of group, but no other significant effects or interactions. Whereas the ASD sample, regardless of age, performed worse than the matched controls, no differential effect was present for the three MOT conditions. Given these results, the authors concluded that participants with ASD were equally affected by this type of common motion grouping cue as their TD peers.

The third study was conducted by Evers et al. (2014), who investigated the extent to which connection-based grouping affected the allocation of attention and co-occurring tracking ability in children and without ASD (6–10 years old). Their study was inspired by earlier work of Scholl et al. (2001) on the detrimental effects of target grouping in TD adults. Evers et al. used two distinct trial conditions: one connection-based, grouped condition, where targets and distractors were connected with a single line, and one ungrouped, baseline condition, where targets and distractors were not paired. Although both participant groups suffered from connection-based grouping (in line with the 'grouping hurts' condition by O'Hearn et al. 2013), the ASD group experienced significantly less grouping interference compared to the TD peers. These results were interpreted as indirect evidence for a reduced bias towards global processing in ASD, specifically through the influence of grouping on how attention automatically selects information.

The grouping interference research by Scholl et al. (2001) and Evers et al. (2014) shows how one can modify the MOT paradigm to investigate how visual information is automatically and spontaneously organized by the viewer and how individual differences in how information is being captured by attention, can affect task performance. Scholl et al. (2001) not only looked at *connection-based grouping*, which had inspired the study by Evers et al. (2014), but also looked at other types of grouping, such as *object-based grouping*.[1] They did this by altering the tracking displays in various ways so that target and distractor appeared to be distinct parts of the same integral object, rather than merely two items being connected to each other (see Fig. 1). Results showed that, compared to the baseline condition where participants could track 3 out of 4 targets, on average, tracking performance dropped to ±2.5 in case of connection-based grouping, and to ±1.5 for the various types of object-based grouping. These results by Scholl et al. (2001) have provided strong evidence for the object-based nature of tracking, and the (sometimes obligatory) object-based nature of attention allocation, in general. This line of work is largely complementary to more traditional theories on attention that have often emphasized the fundamentally spatial nature of attention (cf. the well-known "spotlight" or "zoom lens" metaphors, Eriksen and James 1986; Posner et al. 1980) and have ignored the important role that the structure of the attended information can play. The effect of object-based grouping on tracking ability in ASD, however, has not been investigated previously.

Research on atypical perceptual organization in ASD has long been about capturing striking differences between ASDs and non-ASD, before researchers started to realize that differences between both populations do not present in such a black-and-white manner. Along that line, more and more research indicates how differences between ASD and non-ASD often do not occur when tasks rely on explicit information processing, and participants are provided with clear instruction as what to expect, or how to handle the task best. More recently, differences in perceptual organization are less often attributed to core deficits or a lack of capabilities, but rather understood as differences in natural tendencies or automatic, spontaneous behavior to look, read, interpret, or capture (visual) information in a particular way. The MOT paradigm, for this reason, turns out to be quite useful as it allows researchers to investigate perceptual organization in a subtle and implicit manner, by investigating the allocation of attention.

The aim of the current study was to investigate atypical perceptual organization in children with ASD by looking at attentional objecthood and how object-based grouping affects tracking performance. As mentioned earlier, no previous MOT study has investigated the impact of object-based grouping in ASD (nor in children in general). To examine the effect of object-based grouping, we presented a modified version of the MOT paradigm to a group of children with and without ASD (8–14 years old). The task included one ungrouped, baseline condition, where targets and distractors were not paired to each other, and two grouped conditions, where targets and distractors were paired in two different manners (either paired by four randomly placed lines or paired to form the shape of an elongated Necker cube).

Previously, Scholl et al. (2001) have found stronger detrimental effect for object-based grouping than for connection-based grouping, and Evers et al. (2014) have found diminished grouping interference for connection-based grouping in children with ASD. Therefore, we predicted a large differential effect of grouping interference, i.e., stronger grouping interference in TD children than was shown for connection-based grouping (in line with Scholl et al.), and subtle grouping interference for children with ASD (in line with Evers et al.). If children with ASD are less automatically drawn to process information in a global manner, then they would be less inclined to represent the pairs of target stimuli as whole objects, and their tracking ability would suffer less from such object-based grouping than performance of their TD peers.

Methods

Participants

We administered our research protocol to two groups of 8-to-14-year old children, matched on age, gender and IQ. Demographic details of both the ASD group and the TD group can be found in Table 1.

The ASD group consisted of 26 children, previously diagnosed by a child psychiatrist or multidisciplinary team, according to DSM-IV-TR criteria (American Psychiatric Association 2000). Recruitment was set up via the Autism Expertise Centre of the University Hospital in Leuven. ASD diagnoses were re-evaluated within the research protocol using the Dutch version of the Autism Diagnostic Observation Scale conducted by a trained clinical psychologist (ADOS: Gotham et al. 2006; Dutch version: de Bildt et al. 2009). ASD phenomenology was measured using the Social Responsiveness Scale (SRS: Roeyers et al. 2011). Twenty-five of the 26 children with a clinical ASD diagnosis scored above the ADOS autism spectrum cut-off criterion, while 23 children scored above T70 on the SRS (T70 refers to a norm score of two standard deviations from the mean). Since the analyses did not differ depending on

[1] One could argue that all types of grouping used by Scholl et al. (2001) are forms of object-based grouping, even those where target and distractor were grouped by as little as a dotted line, and that merely the precise *strength* by which a perceptual object (or proto-object) is generated, varies. However, for clarity reasons, we will use the term *object-based grouping* only to refer to those types of grouping that actually generate the percept of a single 3D object.

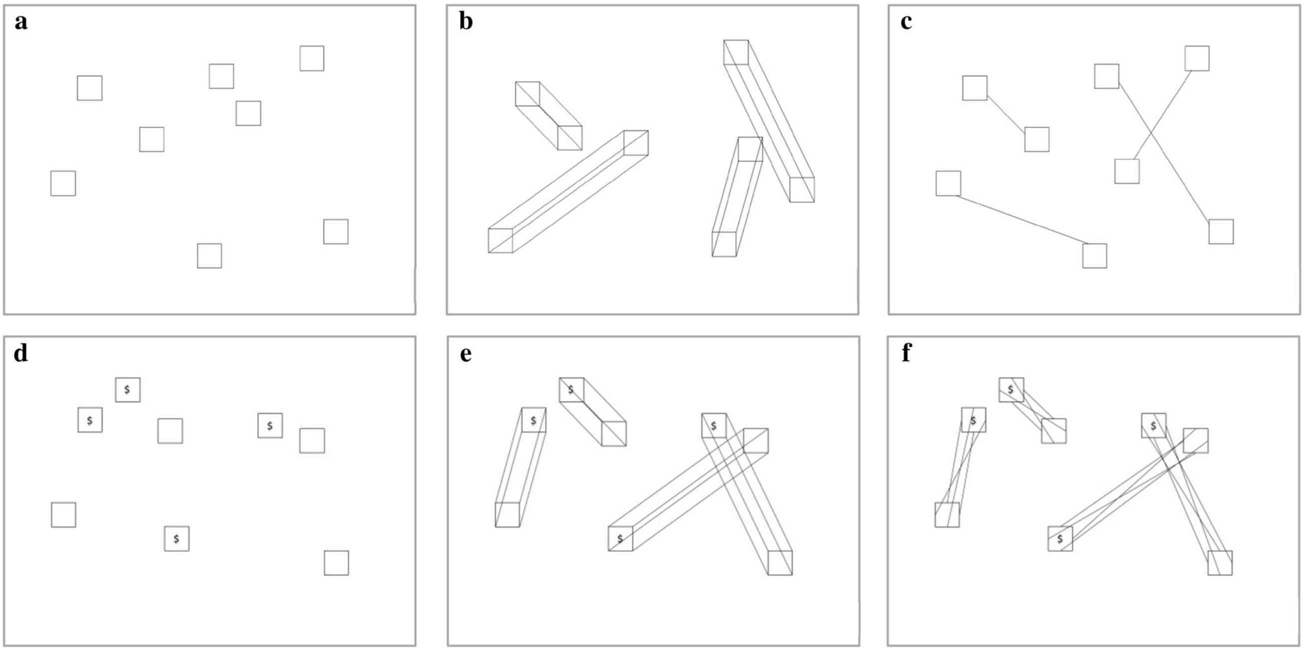

Fig. 1 **a–c** are illustrations of some of the stimuli used by Scholl et al. (2001) and Evers et al. (2014). **a** represents the "boxes" condition, **b** represents the Necker Cubes condition, and **c** represents the Dumbbells condition. **d–f** are illustrations of the three conditions used in the current study. **d** represents our ungrouped "boxes" condition, **e** represents our Necker Cube connection and **f** represents our Necker Control condition. Note that **a** and **d** are ungrouped conditions, that **b** and **e** are examples of object-based groupings and that **c** and **f** are examples of connection-based grouping. The stimuli for the current study were based on the stimuli from Scholl et al. (2001). None of the stimuli are drawn to scale

Table 1 Descriptive statistics on the ASD and matched TD group

	ASD group (n = 26: 19 boys, 7 girls)		TD group (n = 27: 17 boys, 10 girls)		Two-sided t test
	Mean (SD)	Range	Mean (SD)	Range	p value
Age	10.35 (1.58)	7.99–13.03	10.25 (1.18)	8.48–12.15	.7920
VIQ	98.04 (14.59)	65–129	103.93 (12.97)	78–133	.1264
PIQ	103.46 (12.81)	83–129	103.70 (13.78)	77–129	.9475
FSIQ	101.12 (12.75)	77–130	103.81 (11.45)	81–128	.4209
SRS	90.62 (16.57)	56–132	48.41 (5.71)	37–60	<.0001
ADOS	5.96 (1.71)	2–9	N/A	N/A	N/A

Descriptive statistics ad p values of a two-sample t test with a two-tailed distribution for age (depicted in years), verbal intelligence scores (VIQ), performance intelligence scores (PIQ), full scale intelligence scores (FSIQ), SRS total scores and ADOS scores

whether we in- or excluded the participants scoring below the ADOS cut-off or SRS T70 score, results of the full ASD group are reported.

The TD group consisted of 27 children recruited through a local mainstream school. None of the TD children suffered from a known child psychiatric disorder, nor did any of them report having a first-degree family member with ASD. As in the ASD group, ASD phenomenology was measured using the SRS (Roeyers et al. 2011). None of the TD participants scored above the SRS T70 score, so results of the full TD group are reported.

Intellectual abilities for all participants were assessed by administering an abbreviated version (Sattler 2001) of the Wechsler Intelligence Scale for Children, Third Edition (WISC-III-NL; Wechsler 1992). All participants reported normal or corrected-to-normal vision. None of the participants reported to be taking any type of neuroleptics, neither did any of them take part in previous studies regarding MOT.

Stimuli

The stimuli and research design (Fig. 1) were based upon the 'Boxes', 'Necker Cubes' and 'Necker Control' conditions from Scholl et al. (2001), with additional changes made to make the task more game-like for children.

The Boxes condition served as a baseline condition: all eight items were presented as individual squares that moved individually from all others (Fig. 1d). The Necker Cubes condition displayed one target and one distracter connected to each other with four lines (each vertex of a target box connected to a corresponding vertex of the distracter box). Although connected, target and distracter continued to move completely independently of one another. By connecting a target and a distracter square, each pair visually merged into a 3D Necker Cube (Fig. 1e). The Necker Control condition was set up as a control condition to verify that any differences in performance between the Boxes and Necker Cubes condition, were not due solely to the four lines that were added to the visual display (Fig. 1f). Target and distracter squares were grouped with four connecting lines, but rather than connecting the vertices, connecting lines were attached to the middle of each side of the squares and crossed mid-way connecting the second square. This alteration maintained a similar amount of visual clutter but did not result into a 3D Necker Cube visual percept. Similar as in the Necker Cubes condition, all target and distracter squares, even though connected, continued to move independently of one another. Movement trajectories were designed in such a way that, although the connecting lines would often overlap during movement, the actual targets or distractors squares would never fully overlap with each other.

Procedure

The experiment was designed to test children's ability to track multiple objects, moving among distractors, in one ungrouped and two grouped conditions. All participants were tested during an individual testing session in a soundproof and slightly darkened room. Participants were seated on an adjustable chair in order to ensure height and viewing distance from the screen (approx. 57 cm) were comparable for each participant.

At the start of each trial, a static display with eight identical squares was presented. After one second, the outline of four target squares lit up and a dollar sign appeared within. After 4 s, the outlines turned back to their initial color and the dollar signs disappeared. Next, all eight squares began moving randomly across the screen at an average speed of 2.8° per second, following independently determined paths (using Bézier curves to create smooth movements). After 8 s, all squares stopped moving and participants were asked to use the computer mouse to indicate which four of the eight squares presented were the four, previously indicated, target squares. Participants received immediate feedback: when they provided a correct answer, a golden dollar sign appeared and a sound ('ka-ching') was played; when their provided answer was incorrect, the indicated square turned grey. For each trial, four squares had to be selected, even if the participant had to guess in order to indicate four possible targets. Once a participant had selected four squares, he or she was asked to press the space bar to move on to the next trial.

Participants completed three practice trials with six squares (three targets, three non-targets) and three practice trials with eight squares (four targets, four non-targets), before commencing with 60 test trials with eight squares (four targets, four non-targets). All three stimulus conditions (i.e., Boxes, Necker Cubes, and Necker Control condition) were presented in equal quantities, all intermingled, both during the practice runs and when completing the test trials. At all times, participants were instructed to track the indicated squares, which would move amongst the distractors, irrespective of the grouping condition.

Data-Analysis

All analyses were conducted with a repeated-measures mixed model analysis using the general statistical software package SAS (Version 9.3; SAS Institute Inc., 2011). Assumptions of normality and homogeneity were checked by means of a visual inspection of the histogram, qq-plot as well as a Shapiro–Wilk and Kolmogorov–Smirnov test. Significance tests were conducted with a significance level of 5 %. Post-hoc tests were Tukey–Kramer corrected.

Similar to Evers et al. (2014), three average scores (one per condition) and one overall interference score were computed for each participant. The average scores refer to the average number of correctly identified targets (possible range 0–4) across trials within a particular condition. The grouping interference scores refer to the strength of the grouping interference that was experienced, and were calculated by subtracting the average score of the Necker Cubes trials from the average score of the Boxes trials (and discarding performance on the Necker control trials). Note that the results on the interference scores did not change when the interference scores were calculated by subtracting the combined, average score of the Necker Cubes and Necker Controls trials, from the average score of the Boxes trials. All necessary summary statistics can be found in Table 2.

Results

Mixed Model Analysis

A repeated-measures mixed model analysis with grouping condition and participant group as fixed factors and a random intercept for each subject, revealed a main effect of grouping condition, F (2, 102) = 84.72, $p < .0001$.

Table 2 Accuracy scores for both participant groups in all three grouping conditions

	ASD group Mean (SD)	TD group Mean (SD)	*df*	*t*	Adj. *p* value
Boxes	3.61 (.42)	3.74 (.37)	88.1	−0.90	0.9453
Necker cubes	2.81 (.58)	3.08 (.50)	88.1	−1.89	0.4158
Necker control	2.98 (.57)	3.10 (.54)	88.1	−0.84	0.9600

Accuracy scores for all three grouping conditions are displayed for both groups. The adjusted *p* values are Tukey–Kramer corrected

Post-hoc analysis revealed that both within- and across groups, performance was significantly better in the ungrouped condition, compared to either of the grouped conditions ($p < .0001$), and performance in the grouped conditions (Necker Cubes object-based vs. Necker Control connection-based) did not differ from each other ($p > .30$). There was no evidence of an overall difference in performance between both groups, $F\ (1, 51) = 1.98, p = .17$, nor a Participant Group x Grouping Type interaction effect, $F\ (2, 102) = 0.88, p = .42$ (see Fig. 2).

Degree of Grouping Interference

A two-sample t test, equal variances assumed, F (25, 26) $= 1.14$, $p = .75$, showed that the degree of grouping interference experienced by the ASD group did not differ significantly from the grouping interference experienced by the TD group ($t\,(51) = 1.02, p = .31$; ASD: $M = .80, SD = .50$; TD: $M = .66, SD = .47$, see Fig. 3). The task-irrelevant, object-based grouping of targets with distractors seemed to impact performance of both groups to a similar extent.

Correlations Between the Interference Score and Standardized Measures

Pearson correlations were conducted to evaluate to what extent the MOT performance was linked to age, ASD-symptomatology or intelligence. The correlations are reported for both participant groups separately, as well as the whole sample, as some of the reported correlations do not show a similar pattern for both groups. Age of the ASD group, TD group or the whole sample did not correlate significantly with the interference scores ($ps > .11$). FSIQ correlated significantly with the interference scores for the ASD group but not the TD group (ASD: $r\ (26) = -.51$, $p = .008$; TD: $r\ (27) = -.31$, $p = .12$). A significant correlation between FSIQ and the whole group interference scores, however, was present, $r\ (53) = -.42$, $p = .002$. Similar within-group and whole-group correlations were found between VIQ and PIQ and the interference scores. The SRS scores of the ASD group, TD group or the whole sample did not correlate significantly with the interference scores ($ps > .42$). Hence, the size of the grouping interference effect did not relate directly to the number of ASD traits reported. The ADOS severity scores of the ASD group did not correlate with the interferences scores ($p > .75$).

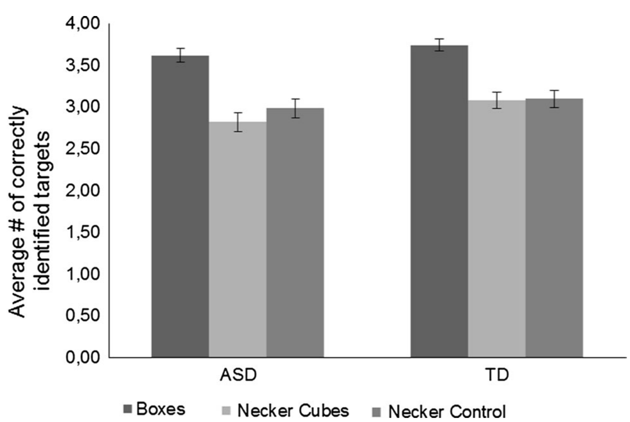

Fig. 2 Mean accuracy scores on the MOT task for the ASD and TD group in the three conditions

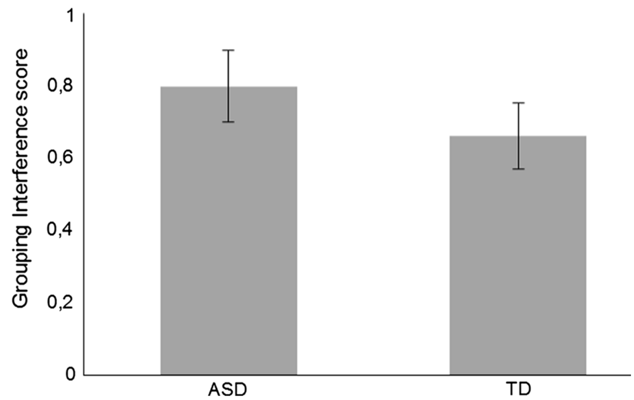

Fig. 3 Interference scores on the MOT task for the ASD and TD group

Discussion

The current study aimed at investigating perceptual organization in children with (and without) ASD by looking at attentional objecthood and how object-based grouping affects MOT performance. As this is not the first study to investigate MOT performance in ASD, it is essential to evaluate to what extent our results (mis)match the previous findings. In doing this, however, it becomes important to note that generalizing across these studies is complicated by the fact that the experimental designs were not identical and each study tested different participants.

First of all, our results showed no *overall* group difference between the ASD and TD group; both groups proved equally able in object tracking. This finding is in line with the results by Evers et al. (2014), who found group differences in grouping interference scores, but no *overall* group difference. However, the lack of an overall group difference contrasts with the findings of both Koldewyn et al. (2013b) and O'Hearn et al. (2013), who found overall diminished MOT performances for their ASD participant groups. Note that the presence or absence of an *overall* group difference in these four studies cannot be related to differences in the age of the samples or the type of group matching, but seems due to the particular type of MOT modifications used (or the particular participant samples).

Secondly, our results revealed a similar degree of grouping interference in both the Necker Cube and Necker Control condition (both within- and across-groups). This suggests that tracking ability in children with or without ASD was equally affected by both types of grouping, regardless of whether it yielded 3D Necker cube objects or odd 2D shapes. This pattern of results is inconsistent with that of Scholl et al. (2001) as they found a clear difference in performance between the Necker Cubes and Necker Control condition in TD adults: whereas performance dropped significantly in their Necker Cubes condition (items accurately tracked = ± 1.5), performance reached baseline level in their Necker Control condition (items accurately tracked = ± 3). Participants' performance in their Necker Control condition resembled that of a condition where no grouping cues were present, even though the physical constitution of this condition only differed minimally from their Necker Cubes condition. The striking inconsistency between the results of Scholl et al. (2001) and those of the current study seems to suggests that the pairing of targets with distractors as displayed in the Necker Control condition is not strong enough to elicit grouping interference in TD adults, while it is strong enough to prove detrimental on tracking ability in both TD children and children with ASD. Although the grouping mechanism in the Necker Control condition was connection-based (and did not yield the percept of a solid, 3D object), comparison of the interference scores shows that the detrimental effects in this condition, both for children with or without ASD, were far more comparable to those obtained in the object-based Necker Cubes condition than to those in the connection-based Dumbbell condition, used by Evers et al. (2014). Taken together, these results raise questions about the developmental trajectory underlying automatic object formation. A previous study by Scherf et al. (2009) on the developmental trajectories of different types of perceptual grouping has suggested that, in contrast to other types of grouping, the ability to perceptually group few large elements or the process of gathering shape information from perceptual grouping, only develops late into adolescence. This kind of late development could explain why the grouping effects obtained in both the current study and the study by Evers et al. (2014), testing participants groups up to 14-year old only, differ from the expectations based on adult studies.

Last but most importantly, the current study found the level of grouping interference experienced by the ASD sample to be similar to that experienced by the TD sample. While we predicted a large difference in interference scores between the groups, no differential effect of grouping interference was obtained. This contrasts with the findings of Evers et al. (2014) who found their ASD group to experience significantly less grouping interference compared to their TD peers. A first important factor in understanding this finding relates to the type of grouping cues used. In the experiments by Scholl et al. (2001) it was shown that the detrimental effects of grouping were significantly stronger for the object-based pairing than for the connection-based pairings. Therefore, it seems likely that the lack of strong global processing tendencies, the underlying mechanism suggested by Evers et al. (2014), allowed the ASD group to ignore task-irrelevant grouping, but only when the strength of grouping allowed for it. While the children with ASD proved to be able to ignore the subtle connection-based grouping used by Evers et al. to a larger extent than their TD peers, they failed to do so, as did their TD peers, when presented with stronger grouping cues as presented in the current study. This idea is supported by the size of the interference scores, which are, on average, .12 in the study by Evers et al., and .73 in the current study (the larger the interference score, the larger the performance difference between the ungrouped vs. grouped condition). As the baseline conditions of both studies were identical, the differences in experienced interference (expressed by the interference score) can only be related to the strength of interference experienced in the grouped condition. A second factor as to why no differential effect of grouping interference was found, might lie in the ratio of grouped versus ungrouped trials that was administered. Whereas Evers et al. (2014) applied a 1:1 ratio of grouped versus ungrouped trials, the current study, similar to the study by O'Hearn et al. (2013), applied a 2:1 ratio of grouped versus ungrouped trials. This 2:1 trial ratio might have induced an unwanted focus on global targets or object formation, or at least, allowed for more learning to occur for global, grouped trials compared to ungrouped trials. While performance of the TD samples (both adults and children) was similar across these three studies, performance of the ASD samples was not. This seems to suggest that the ASD samples show greater sensitivity to the specific stimulus sets or trial ratio administered, and/or that they are characterized by greater heterogeneity. Previous research by Koldewyn et al. (2013a) and Nakahachi et al. (2006) has pointed out that task performance in ASD can be more sensitive to particular task characteristics than performance of TD individuals.

In sum, the current study demonstrates that object-based grouping affects tracking performance in both children with and without ASD. No differential effect of grouping interference was found. Overall, these results are a strong indication that research on perceptual organization in ASD (1) should focus more on within-subject manipulations to evaluate sensitivity to subtle task and stimuli related differences and (2) should include a wider age range of participants to reveal clearer developmental trajectories in the data.

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